Osgood,[9] whereas the American Falls specimens have even heavier and longer horns which stand out from the side of the skull somewhat more than in the type. It is estimated that the distance between the extremities of the horn-cores on one of the specimens, though the tips are not complete, would be about 680 mm. The anteroposterior diameter at the base of the horn is about 115 mm. and the vertical diameter about 102 mm.

[9] Osgood, W. H., Smithsonian Misc. Coll., Quart. Issue, 3: pt. 2, 173–185, pl. 40, fig. 1, pl. 41, fig. 1. 1905.

BIOLOGY.—*Longevity and fertility in the pond snail,* Lymnaea columella.[1] Charles P. Winsor and Agnes A. Winsor. (Communicated by Raymond Pearl.)

The essential preliminary to any reasoned, quantitative discussion of population problems is accurate knowledge of birth and death rates. Unfortunately, such knowledge is almost completely non-existent. Aside from our knowledge about man, virtually everything that we know of birth and death rates in other forms is due, directly or indirectly, to Pearl. Under these circumstances it seems legitimate to add a certain amount of data, even though it fails to conform in all respects to the standards set by Pearl on *Drosophila.*

The data here presented deal with duration of life and fertility in the pulmonate gastropod *Lymnaea columella.* Some account of the biology and laboratory husbandry of this animal has already been given by Baily (1) and by ourselves (7).

The conditions under which the observations were made may be stated briefly. Eggs from wild snails isolated in the laboratory were collected and separated before hatching; from each egg mass 10 eggs were placed in one finger bowl and 2 eggs in each of five others. A total of 180 snails was used in each series. Leaf lettuce was used as food, except for a period of about four weeks during which iceberg lettuce was used. The substitution was unavoidable, and unfortunate. Lettuce and water were changed three times a week; the conditions were arranged so that light and temperature were reasonably uniform or all animals.

The wild parents of the snails were collected in two ponds in the vicinity of Baltimore, designated here as the Falls Road pond and the Boyce Avenue pond. In addition to these wild ancestors of known origin, two snails isolated from laboratory aquaria furnished eggs for

[1] From The Department of Biology of The School of Hygiene and Public Health, The Johns Hopkins University, and The Biological Laboratories, Harvard University. Received March 14, 1935.

this experiment; nothing is known concerning their origin. These animals were isolated in the laboratory in finger bowls with about 150 ml. of spring water, fed with leaf lettuce, and their eggs collected

TABLE 1.—PERCENT SNAILS SURVIVING AT GIVEN AGES (RECKONED FROM OVIPOSITION)

Age in Days	Percent Surviving Initial Density 2	Percent Surviving Initial Density 10
15	100.0	100.0
25	91.6	76.4
35	79.9	62.4
45	77.1	47.9
55	76.0	47.3
65	74.9	45.5
75	74.3	45.5
85	74.3	45.5
95	70.4	43.7
105	70.4	42.5
115	68.2	38.8
125	67.0	37.6
135	64.3	34.6
145	60.9	34.0
155	50.3	31.0
165	41.9	25.5
175	30.7	22.5
185	18.4	10.9
195	4.5	4.8
205	2.2	0.6
215	1.1	0.0
225	0.0	

daily. The eggs so obtained were allowed to develop for about a week, at which time healthy-appearing clutches were selected for the experimental population. These eggs were removed from the capsule and placed in finger bowls with spring water.

TABLE 2.—BIOMETRIC CONSTANTS OF DURATION OF LIFE

	Initial Density 2	Initial Density 10
Mean	128.8 ± 3.2 days	88.7 ± 3.6 days
Standard Deviation	63.4 ± 2.3 days	70.2 ± 2.5 days
Coefficient of Variation	49.2 ± 2.1%	79.1 ± 5.3%

Table 1 and Figure 1 show the survivors at given ages out of 100 snails hatching. Table 2 gives the mean, standard deviation, and coefficient of variation of duration of life for each series.

It will be observed that these life tables differ from those hitherto published for *Drosophila* and other forms, in that there is present a high infant mortality. We do not feel entirely certain, however, that this mortality is not at least partially attributable to experimental technique. Of the total deaths under forty days, just over half, in each series, were due to snails crawling out of water and drying on the dish (45

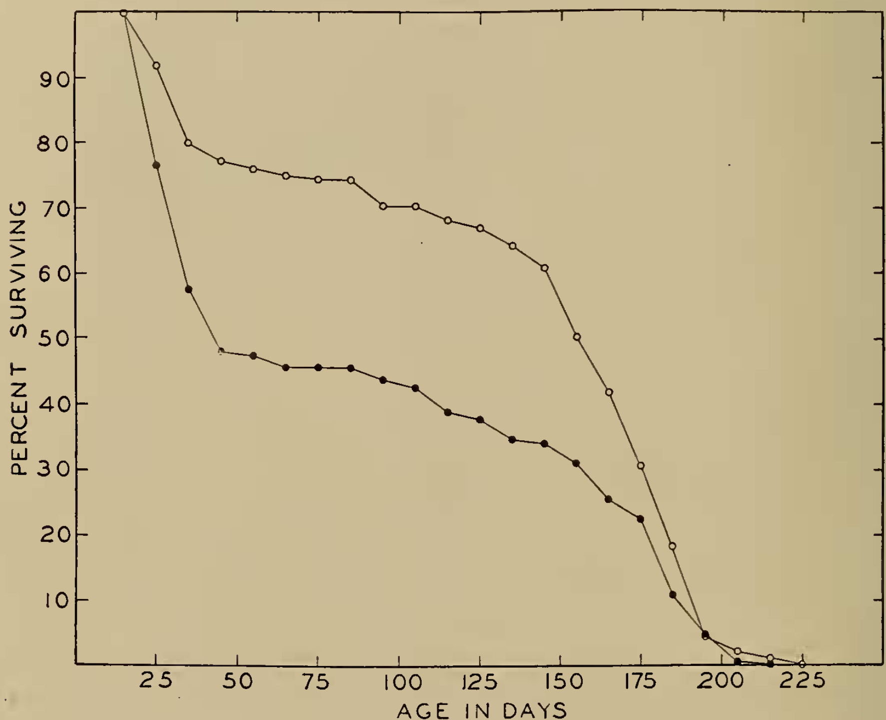

Fig. 1.—Percent snails surviving to given ages. Open circles density 2; solid circles density 10.

out of 85 deaths in the 10 snail series, 22 out of 40 in the 2 snail series). But we may observe that (a) this mortality is markedly higher in the high density series, and (b) there remains a high infant mortality even after deaths from desiccation have been excluded. Whether improved technique would eliminate infant mortality is not certain, though we are disposed to believe that it would.

We may further note that except for infant mortality there are no significant differences in the life tables at the two densities.

In Table 3 are presented data relative to egg production. In this table we have indicated the parentage of the snails considered, and for each parent we have grouped the data according to the density at the date of deposition of the first eggs. We have calculated in each case the egg production per snail at each density, and also the egg production per snail-day in excess of 70 days. (The figure of 70 days corresponds approximately to the date of earliest egg production; no es-

TABLE 3.—Egg Production

Parent	Density	Number of Cases	Total Eggs	Eggs per Snail	Total Snail-days over 70	Eggs per Snail-day
1	3	1	658	219	260	2.53
	2	2	1,298	325	276	4.70
	1	2	1,604	802	189	8.48
2	7	1	1,283	183	664	1.94
	6	1	1,116	186	577	1.94
	5	1	1,729	346	422	4.09
	2	10	18,542	927	1,573	11.15
	1	4	3,907	977	308	12.66
4	5	2	7,316	732	813	9.00
	3	1	594	198	147	4.04
	2	9	22,489	1,249	1,748	12.86
	1	4	7,360	1,840	430	17.12
8	4	1	1,404	351	326	4.31
	2	7	4,941	353	1,076	4.59
	1	4	3,512	878	408	8.61
12	4	1	1,731	433	405	4.27
	2	8	9,729	608	1,571	6.19
	1	3	3,048	1,016	346	8.81
15	5	1	3,404	681	530	6.42
	2	4	6,192	774	856	7.23
	1	1	51	51	57	.90
16	8	1	2,427	303	588	4.13
	4	1	2,724	681	481	5.66
	2	8	11,090	693	1,737	6.38
	1	2	1,431	715	188	7.61
17	3	1	1,972	657	339	5.82
	2	3	4,609	768	660	6.98
	1	1	778	778	123	6.33
A-2	3	1	2,367	789	241	9.82
	2	1	2,640	1,320	222	11.89
	1	5	8,404	1,681	541	15.53
A-3	3	1	4,398	1,466	358	12.28
	2	3	5,948	991	530	11.22
	1	2	3,023	1,511	206	14.67

sential change is introduced if we use some other figure, as 60 days, or even if we use total snail days.)

There are two features of this table which deserve comment. First, considerable differences in fertility exist from one strain to another, which suggest genetic differences. Second, and more important, there is a clearly marked effect of density of population on fertility. With very few exceptions, there is a regular increase in fertility per head, however measured, as density decreases. (The exceptions may reasonably be attributed to sampling fluctuations.) We thus see that in these animals the same effect of density on fertility exists which Pearl (5) has found in *Drosophila.* Whether the mechanism of the effect is similar cannot at present be stated.

A third point which seems to us of some interest relates to the reproductive physiology of these animals. As we have already shown, isolated animals lay more eggs than pairs. Further, observation indicates that the proportion of viable eggs is as high in the eggs laid by singles as in those laid by paired animals. On the other hand, Boycott and Diver (2), who, in the course of their genetic work have raised enormous numbers of *Lymnaea,* state that cross-fertilization is apparently the rule; and that isolated animals will reproduce, but apparently only as a last resort, their egg production beginning markedly later than that of pairs.

TABLE 4.—Age in Days at First Oviposition, Pairs and Singles

Pairs			Singles	
Wild Parent	Number of Dishes	Mean Age at First Oviposition	Number of Dishes	Mean Age at First Oviposition
1	2	91.0	2	122.0
2	10	77.7	4	75.0
4	9	78.4	4	77.0
8	6	95.3	4	87.3
12	7	82.9	3	78.7
15	4	85.7	1	94.0
16	7	93.1	2	82.5
17	3	91.3	1	92.0
A-2	1	81.0	5	72.8
A-3	3	76.3	2	76.5
General Mean		86.2		82.3

We have examined our records and present in Table 4 data showing the mean age at first oviposition of singles and pairs. We have grouped the animals by parentage, because there seem to be considerable differences among strains as to age of reaching maturity. The numbers are not large, and the results not too consistent; but we think it is clear that singles lay at least as early as pairs. Whether this difference between our results and those of Boycott represents a difference in the physiology of the species, or a difference in experimental conditions, we cannot say.

The interest of the observation, we may remark, lies in the problem it suggests. We know that the animals are hermaphroditic and capable of self fertilization; but we also know, from Boycott's work and from that of Piaget (6), that cross-fertilization takes place if opportunity is offered. The anatomy of the animals, as Crabb (3, 4) has shown, would appear to make cross-fertilization extremely improbable, unless some physiological mechanism not apparent anatomically actively favors foreign sperm. What the nature of this mechanism may be seems a problem worth the attention of some qualified worker.

SUMMARY

(1) Life tables for *Lymnaea columella* are presented for two different initial densities, 2 and 10 snails per dish.

(2) Data on egg production show differences in fertility between strains, and show marked reduction in fertility with increasing density of population.

(3) No significant differences exist in the date of first oviposition as between isolated and paired animals.

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BOTANY.—*Three new plants from Death Valley, California.*[1] C. V. MORTON, National Museum. (Communicated by FREDERICK V. COVILLE.)

The following three new species are from the collections made in Death Valley in 1931 and 1932 by Dr. Frederick V. Coville and associates, under the sponsorship of the National Geographic Society.

Ephedra funerea Coville & Morton, sp. nov.

Frutex pallidus, dioicus, erectus, usque ad 1.3 m. altus, ramosissimus; ramuli teretes, ca. 3 mm. crassi, striati, asperi, glandulosi, apice pungentes;

[1] Published by permission of the Secretary of the Smithsonian Institution. Received March 25, 1935.